
CLAIMS

[Claim(s)]
[Claim 1] The semiconductor device characterized by having had the semiconductor device, the submounting substrate which laid said semiconductor device in one side, and the radiator prepared in the another side side of said submounting substrate, and preparing a chromium layer or a titanium layer with a thickness of 0.03 micrometers or more between said semiconductor device and said submounting substrate.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the semiconductor device which consists of structure which mounts a semiconductor device on a submounting substrate with respect to a semiconductor device.
[0002]
[Description of the Prior Art] In order to make it continue for a long

period of time that a semiconductor laser component carries out continuous oscillation at a room temperature and to hold the super-life, it is required to radiate heat efficiently in the heat generated from the barrier layer of a semiconductor laser component, and to lower operating temperature. Then, although he is trying to miss this heat by soldering a component to a heat sink (radiator), generally the upside down type which joins the end face of the side near the barrier layer of a component to a heat sink then is adopted. However, since coefficients of thermal expansion differ greatly, if a semiconductor laser component and a heat sink join these directly, the transitional layer called a dark line by the internal stress produced in the barrier layer of a semiconductor laser component in the coagulation process after melting of solder will occur, the oscillation threshold current of a component will go up, and the oscillation of them will become impossible.

[0003] Therefore, the approach of using solder, such as tin, and joining a semiconductor laser component between a heat sink and a semiconductor laser component, on the GaAs substrate of a semiconductor laser component and the submounting substrate between which almost equal silicon, molybdenum, etc. of a coefficient of thermal expansion were made to be placed as some heat sinks, is usually taken.

[0004] Drawing 2 is the sectional view showing the mounting structure of the semiconductor device of the 1st conventional example. On mirror-polishing side 1a of one side of the silicon substrate (submounting substrate) 1 for mounting the semiconductor laser component 5, the tin solder layer 4 is formed for the titanium layer 8, the platinum layer 9, and a gold layer 10 with vacuum deposition or plating after laminating formation one by one by a spatter etc. Furthermore, the semiconductor laser component 5 is carried on the tin solder layer 4, it heats to predetermined temperature, melting coagulation of the tin solder layer 4 is carried out, and the semiconductor laser component 5 is joined on a silicon substrate 1. In addition, on non-mirror-polishing side 1b of a silicon substrate 1, the tin solder layer 4 is formed with vacuum deposition or plating, and the non-mirror-polishing side 1b side of a silicon substrate 1 is joined on a heat sink (radiator) 6. Since a gold tin alloy is formed, and the semiconductor laser component 5 is joined while the front face has been flat while the tin of the tin solder layer 4 carries out melting coagulation, to barrier layer 5a, the effect of melting solder is almost lost. However, for that, there was a problem which must use very expensive metals, such as the platinum layer 9 and a gold layer 10, and cost raises sharply. Then, the method of using the aluminum layer 2 instead of the platinum layer 8 metallurgy layer 10 was

taken.
[0005] Drawing 3 is the sectional view showing the mounting structure of the semiconductor device of the 2nd conventional example. Once carrying out laminating formation of the aluminum layer 2 by a spatter etc. on mirror-polishing side 1a of one side of the silicon substrate 1 for mounting the semiconductor laser component 5 and taking out in air, the tin solder layer 4 is formed with vacuum deposition or plating. Furthermore, the semiconductor laser component 5 is carried on the tin solder layer 4, it heats to predetermined temperature, melting coagulation of the tin solder layer 4 is carried out, and the semiconductor laser component 5 is joined on a silicon substrate 1. In addition, on non-mirror-polishing side 1b of a silicon substrate 1, the resin 7 which consists of an Ag paste etc. is formed, and the non-mirror-polishing side 1b side of a silicon substrate 1 is joined on a heat sink 6.
[0006]
[Problem(s) to be Solved by the Invention] However, since he is trying to make a tin solder layer form once exposing into air the aluminum layer 2 which aluminum oxidized in air, and it was [aluminum] easy, and was formed, the tin solder layer 4 will be formed in aluminum layer 2 front face with an oxide film, and the adhesion of the aluminum layer 2 and the tin solder layer 4 falls remarkably. Furthermore, generation of heat became large and it had produced the problem of reducing a component life or causing defective continuity in order to increase component resistance of the semiconductor laser component 5, since the oxide film produced on the aluminum layer 2 serves as a potential barrier.
[0007] Then, this invention is made paying attention to the above-mentioned point, and it aims at offering the semiconductor device which is low cost and has reliable mounting structure.
[0008]
[Means for Solving the Problem] The semiconductor device which becomes this invention is equipped with a semiconductor device 5, the submounting substrate 1 which laid said semiconductor device 5 in one side, and the radiator 6 prepared in the another side side of said submounting substrate 1, and is characterized by preparing a chromium layer or a titanium layer with a thickness of 0.03 micrometers or more between said semiconductor device 5 and said submounting substrate 1.
[0009] Since a metal with the high reducibility of chromium or titanium is made to intervene between said submounting substrates which laid the semiconductor device and said semiconductor device and the effect of the

oxide film formed on the submounting substrate is removable, the potential barrier which produces the adhesive property of said semiconductor device and said submounting substrate under the effect of an oxide film while being able to improve sharply can be removed.

[0010]

[Embodiment of the Invention] Hereafter, one example of this invention is explained with reference to a drawing. Drawing 1 is the sectional view showing the mounting structure of the semiconductor device of this invention. The same component as the configuration mentioned above attaches the same sign, and omits the explanation. As for a silicon substrate and 2, 1 is [an aluminum layer and 3] chromium layers. This invention is equal to the thing which made the chromium layer 3 intervene between the aluminum layer 2 and the tin solder layer 4 in drawing 3 .

[0011] Once forming the aluminum layer 2 of 0.5-micrometer thickness by the vacuum deposition method or the spatter on mirror-polishing side 1a of n mold silicon substrate 1 with a thickness of 250 micrometers and taking it out in air, using the photolithography method and the etching method, patterning of it is carried out, it leaves a 500 micrometerx500-micrometer field part, and has removed except [its]. Furthermore, it leaves a 300 micrometerx300-micrometer field part so that a laminating may be carried out on the aluminum layer 2 one by one and the semiconductor laser component 5 which has the magnitude of 250 micrometers can be easily laid at a vacuum deposition method on the 250 micrometerx aluminum layer 2 by which patterning was carried out, and as for the chromium layer 3 of 0.05-micrometer thickness, and the tin solder layer 4 of 0.5-micrometer thickness, except [its] is removed. Next, the semiconductor laser component 5 is carried on said tin solder layer 4, and it heats to predetermined temperature, applying a load, melting coagulation of the tin solder layer 4 is carried out, and semiconductor laser 5 is joined on mirror-polishing side 1a of a silicon substrate 1. Non-mirror-polishing side 1b of a silicon substrate 1 is joined to the last on the copper nickel-gold-plated heat sink 6 through the resin 7 which consists of an Ag paste etc.

[0012] Since a tin-chromium-aluminium alloy is formed, and the semiconductor laser component 5 is joined while the front face has been flat while a tin solder layer carries out melting coagulation as mentioned above, in the field in which the barrier layer 5a is located, most effects of a tin solder layer are lost. Since aluminum is once taken out in air and is performing patterning of the aluminum layer 2 in order that it may tend to oxidize, it is in the condition of being easy

to produce an oxide film, in the front face of the aluminum layer 2. Since the chromium layer 3 has the operation which carries out reduction removal of the oxide film, the chromium layer 3 formed on the aluminum oxide film reacts with an aluminum oxide film, and since it incorporates in the chromium layer 3, strong junction of the bond strength of the aluminum layer 2-chromium layer 3 without an oxide film can perform junction in a chromium layer and an aluminum layer. In addition, since formation of the uniform chromium layer 3 becomes difficult and it stops being able to carry out partial reduction removal of the oxide film of aluminum layer 2 front face when thickness of the chromium layer 3 is set to 0.03 micrometers or less, problems, such as a fall of bond strength and increase of component resistance, arise. For this reason, it is necessary to set thickness of the chromium layer 3 to 0.03 micrometers or more.

[0013] Although chromium was used as a layer with a reduction operation in this example, effectiveness with the same said of titanium is acquired. Moreover, as a solder ingredient, indium solder or lead-tin solder may be used instead of tin solder. In addition, although this example explained using the example of a semiconductor laser component, it cannot be overemphasized that this invention is applicable also to semiconductor devices, such as light emitting diode and FET (field-effect transistor).

[0014]

[Effect of the Invention] Since the oxide film on a submounting substrate is removable by inserting the chromium or titanium which has a reduction operation between a semiconductor device and a submounting substrate according to the semiconductor device of this invention as explained above, the bond strength of said semiconductor device and said submounting substrate can be increased. Moreover, the electrical characteristics of generation of heat and defective continuity accompanying increase of the component resistance under the effect of an oxide film can be improved, and the dependability of a semiconductor device can be raised.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the mounting structure of the semiconductor device of this invention.
[Drawing 2] It is the sectional view showing the mounting structure of the semiconductor device of the 1st conventional example.
[Drawing 3] It is the sectional view showing the mounting structure of the semiconductor device of the 2nd conventional example.
[Description of Notations]
1 -- Silicon substrate (submounting substrate)
2 -- Aluminum layer
3 -- Chromium layer
4 -- Tin solder layer
5 -- Semiconductor laser component
6 -- Heat sink (radiator)
7 -- Resin

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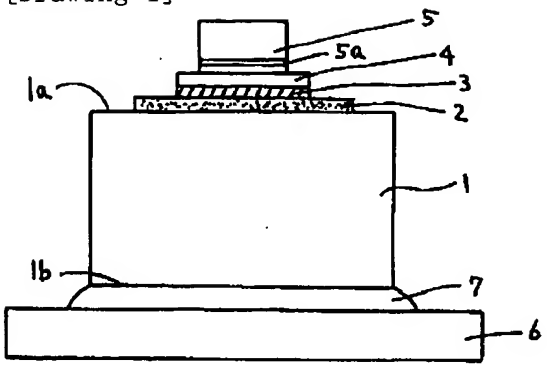
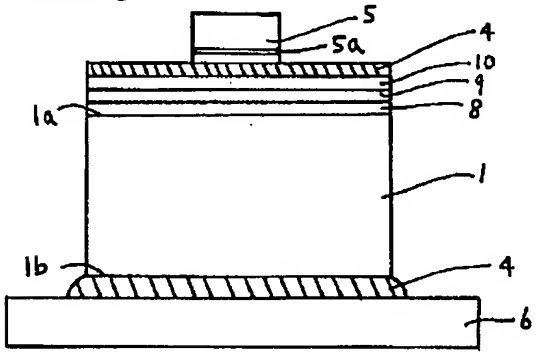
DRAWINGS

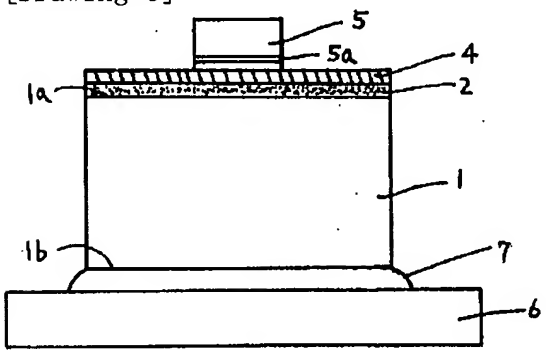
[Drawing 1]



[Drawing 2]



[Drawing 3]



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(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

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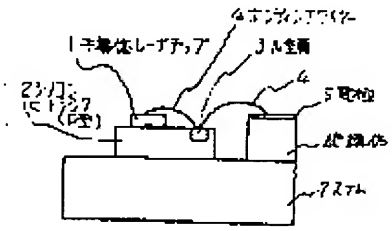
(71) Applicant: NEC CORP
(72) Inventor: KAWARATANI MASAHIKO

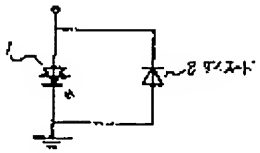
(54) **SEMICONDUCTOR LASER**

(57) Abstract:

PURPOSE: To prevent a semiconductor laser chip from destruction due to excessive electric current by a method wherein the semiconductor laser chip is bonded onto a heat sink provided with a diode having a P-N junction and the semiconductor lase chip is united with the diode.

CONSTITUTION: An N-type layer 3 is formed, by an ion implantation technique, in one part of a heat sink 2 composed of P-type silicon. A semiconductor laser chip 1 is fused and bonded onto the P-type silicon heat sink 2 by using a solder in such a way that the side of the P-type conductivity type is faced downward. In addition, the heat sink 2 is fused and bonded to a stem 7 by using the solder; the side of the N-type conductivity type of the semiconductor laser chip, the N-type layer 3 and an electrode 5 are connected and wired by using bonding wires 4. Thereby, it is possible to prevent a semiconductor laser from destruction due to excessive electric current.





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⑤Int. Cl.⁵　識別記号　庁内整理番号　⑬公開　平成2年(1990)11月15日
H 01 S 3/18　7377-5F

審査請求　未請求　請求項の数 1　(全3頁)

⑭発明の名称　半導体レーザ

⑳特　願　平1-100433
㉒出　願　平1(1989)4月19日

㉑発明者　瓦谷　正彦　東京都港区芝5丁目33番1号　日本電気株式会社内
㉑出願人　日本電気株式会社　東京都港区芝5丁目7番1号
㉔代理人　弁理士　内原　晋

明　細　書

発明の名称

半導体レーザ

特許請求の範囲

第1の導電型半導体で成るヒートシンクの一部領域に第2の導電型領域を設けてPN接合ダイオードを形成し、ヒートシンクの第1の導電型領域表面に、半導体レーザチップの第2の導電型側を接着し、前記半導体レーザチップの第1の導電型側の電極と前記ヒートシンクに形成した第2の導電型領域とを電気的に接続したことを特等とする半導体レーザ。

発明の詳細な説明

〔産業上の利用分野〕

本発明は半導体レーザに関するものである。

〔従来の技術〕

従来の半導体レーザは、第3図Aに示す如く、ヒートシンク2a上に半導体レーザチップ1をソルダーで融着し、これをステム7上にソルダーで組立，一体化していた。この半導体レーザは等価回路で示すと第3図Bのようになっており、過剰電流が印加されると、半導体レーザチップ1に直接過剰電流が流れ、内部破壊または場面破壊を生じ、半導体レーザチップ1がショートして半導体レーザが故障してしまう。

〔発明が解決しようとする課題〕

上述した従来の半導体レーザは、半導体レーザを駆動する場合、作業ミス、回路上のトラブル等で半導体レーザに過剰電流が印加し半導体レーザチップを破壊させるという欠点がある。

本発明は過剰な電流が誤って半導体レーザに流れても、半導体レーザチップが破壊しない構造とすることを目的としている。

〔課題を解決するための手段〕

本発明の半導体レーザは、PN接合を持つダイオードを有するヒートシンク上に、ダイオードの極性と逆極性になるように半導体レーザチップを

接着し、半導体レーザチップとダイオードが回路上並列になる構成になっている。この結果、半導体レーザーに過剰電流が印加した時、ダイオードの耐圧以上であればダイオードがブレイクダウンし、半導体レーザチップではなく、ダイオードに過剰な電流が流れるため、半導体レーザチップは破壊せず、半導体レーザは故障しないという利点がある

〔実施例〕

次に、本発明について図面を参照して説明する。第１図Ａ，Ｂ，Ｃは本発明の第１の実施例を示す図で、Ａは半導体レーザチップ１をＰ型導電型側を下、すなわちＰ側をヒートシンク２に接着して組立てた組立図Ｂは、その等価回路図、Ｃは、半導体レーザチップのＩ－Ｖ特性とダイオードの逆方向特性を示す図である。この実施例では、Ｐ型シリコンで成るヒートシンク２の一部分に、フォトリソグラフィー技術，イオン注入技術を用いてＮ型層３を設けてＰＮ接合ダイオードを形成し、Ｐ型シリコンヒートシンク２上に、Ｐ型導電型側を下にして半導体レーザチップ１をソルダーにて融着した。さらに、このヒートシンク２をステム７にソルダーで融着し、ボンディングワイヤ４を用いて第１図Ａのように半導体レーザチップのＮ型導電型側とＮ型層３及び電極５を接続・配線した。この等価回路は第１図Ｂのようになる。この結果半導体レーザを過剰電流による破壊から防止できる。例えば、半導体レーザに過剰電流２００ｍＡ（電圧２Ｖ程度）で半導体レーザチップ１が破壊するとした場合、第１図Ｃの半導体レーザチップ１の順方向Ｉ－Ｖ特性１０とダイオード８の逆方向Ｉ－Ｖ特性９より、ダイオード８は降伏電圧が耐圧より十分低い２Ｖ程度のものを設定すれば、半導体レーザチップ１に過剰電流は流れず半導体レーザの故障を防止できる。

第２図Ａ，Ｂは本発明の第２の実施例を示す図で、Ａは、半導体レーザチップをＰ側を上に、Ｎ側を下にして組立てた組立図である。第２図Ｂは、この等価回路図である。この実施例では、Ｎ型シリコンから成るヒートシンク２´の一部分に、フォトリソグラフィー技術，イオン注入技術を用いてＰ型層３´を設けてＰＮ接合ダイオードを形成し、Ｎ型シリコンヒートシンク２´上に、Ｐ側上に、Ｎ側を下にして半導体レーザチップ１をソルダーにて融着した。さらに、このヒートシンク２´をステム７にソルダーで融着し、ボンディングワイヤ４を用いて第２図Ａのように半導体レーザチップのＰ側をヒートシンク２´のＰ型層３´及び電極５に接続・配線した。この等価回路は第２図Ｂになる。この結果、半導体レーザを過電流による破壊から防止できるという利点がある。

〔発明の効果〕

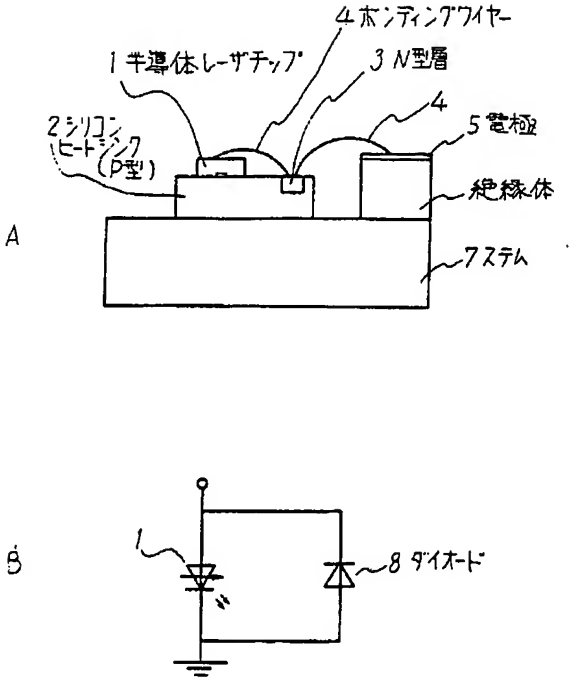
以上説明したように本発明はＰＮ接合を持つダイオードを有するヒートシンク上に半導体レーザチップを接着し、半導体レーザチップとダイオードを一体化したので、半導体レーザチップが過剰電流により破壊することがなくなるという効果がある。

図面の簡単な説明

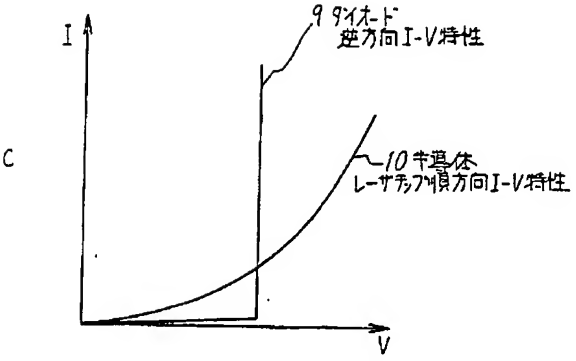
第１図Ａ，Ｂ，Ｃ及び第２図Ａ，Ｂは本発明の半導体レーザの実施例を示す図で、Ａは組立図、Ｂは、Ａの等価回路図、Ｃは、半導体レーザチップとダイオードのＩ－Ｖ特性曲線である。第３図Ａは、従来の半導体レーザの組立図、第３図Ｂは、従来の半導体レーザの等価回路図である。

１…半導体レーザチップ、２，２´，２ａ…ヒートシンク、４…ボンディングワイヤ、５…電極、７…ステム、８…ダイオード、９…ダイオード逆方向Ｉ－Ｖ特性、１０…半導体レーザチップ順方向Ｉ－Ｖ特性。

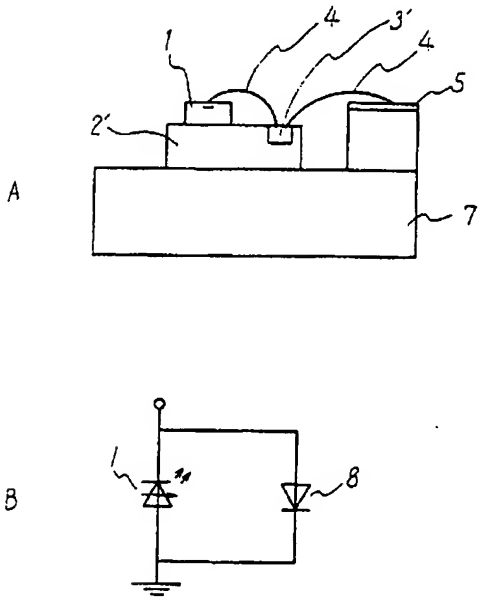
代理人　弁理士　内　原　　晋



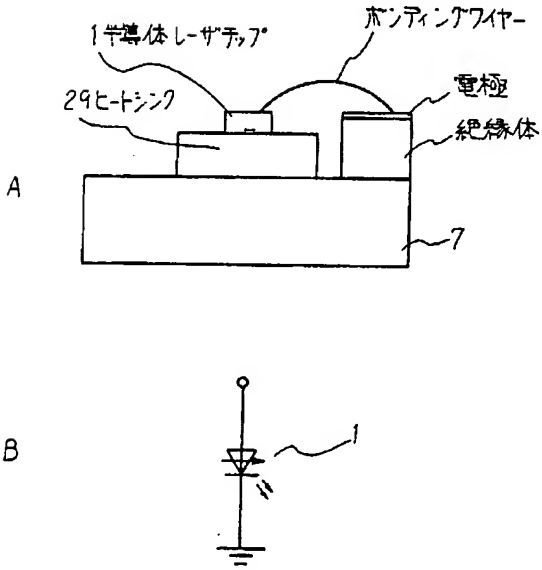
第 1 図



第 1 図



第 2 図



第 3 図